SER EFE-004

Optical Considerations Limiting the Inside Diameter of the Nasmyth Tube
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Since manufacturability tends to limit the maximum diameter of the airbearing, it is desireable to minimize the diameter of the Nasmyth tube. On the other hand, stiffness requirements on the tube will tend to increase its diameter. Nevertheless, it is worthwhile to examine the optical constraints on the tube inside diameter, which is the purpose of this note. The numbers here do not include consideration of light baffles and cooling accommodations which will need to line the inside of the tube.

Definitions (see sketch):
  Dp = primary diameter
  Ds = secondary diameter
  f# = system f-number
  FOV = angular field of view diameter in focal plane
  a = secondary to tertiary distance along optical axis
  b = tertiary to Nasmyth tube entrance distance along optical axis
  c = Nasmyth tube entrance to IR focus along optical axis
  u = a + b + c = Ds f#
  Rir = IR beam radius at entrance to Nasmyth tube
  Cir = radial IR beam clearance at entrance to Nasmyth tube
  Dfov = diametrical clearance needed to accommodate desired FOV at
         entrance to Nasmyth tube for IR and visible beams
  w = separation of the two tertiaries' reflecting surfaces,
      = separation of IR and visible beams
  Rvis = visible beam radius at entrance to Nasmyth tube
  Cvis = radial visible beam clearance at entrance to Nasmyth tube

Formulae and values (all lengths are in inches):
  Dp = 100
  Ds = 15

f# =	12	16	20	notes
FOV = 8 arc minutes				
a = 80				
b = 60				
c = f# (Ds) – (a + b) =	40	100	160	
u = a + b + c =	180	240	300	
Rir = (c/u) Ds/2 =	1.7	3.1	4.0	
Cir = 0.9 Rir =	1.5	2.8	3.6	*
Dfov = (a+b)(FOV)Dp/Ds =	2.2	2.2	2.2	+
w = 2+(b+c)Ds/u+a(FOV)Dp/Ds =	11.2	13.2	14.2	@,$
Rvis = (c-w)Ds/2u =	1.2	2.7	3.6	
Cvis = 1 =	1.0	1.0	1.0	&
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total diameter	19.1	26.0	28.6	

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* assumes diffraction limited beam amplitude is exp(-1.2r/R), with value
     0.3 at edge of geometric beam (radius R); <1% power level is
     intercepted outside of Cir + Rir
+ accommodates both IR and visible beams
@ 2 allows for dichroic tertiary thickness
$ note that this can be reduced by up to about (w-2)/2 if vignetting of
     the visible beam is allowed
& arbitrary

IR FOCUS

VISIBLE FOCUS

NASMYTH TUBE